Input Output Engineering

2025 Core Development Proposal

Version 1.1

Table of Contents

Introduction and Overview

This document presents Input Output Engineering's (IOE) proposal for multiple core budget initiatives, focusing on novel technical core-related developments for Cardano. Over the coming months, IOE plans to work closely with qualified suppliers, DReps, and Intersect to further refine and specify contracting relationships. Throughout this proposal, we use the terms suppliers and collaborators interchangeably.

The proposals detailed herein cover various initiatives critical to Cardano's technical advancement. This submission represents IOE's proposed contribution, and we welcome other ecosystem participants to propose competitive or complementary solutions.

To provide a comprehensive understanding of our core roadmap delivery, these initiatives are presented together in one proposal. We will subsequently solicit community feedback to determine if individual items should be considered separately and will modify our approach based on that input.

Resourcing

The successful delivery of these workstreams relies on collaborative effort involving the deep expertise of the IOE development teams, IO Research (IOR) teams, and longstanding technical collaborators. The combined experience of these groups spans the entire history of Cardano, covering protocol design, formal methods, software engineering, and commercial deployment. Proposed key collaborators contributing to these efforts include, but are not limited to (alphabetized): **Anastasia Labs, BCryptic, dcSpark, Galois, Globant, Greenwave, Lerna Labs, MLabs, Modus Create, Obsidian Systems, PaloIT, PNSol, Quviq, SAIB, Serokell, Sundae Labs, TxPipe, Vacuumlabs, and Well-Typed.**

Financial Considerations

The costs presented below represent the current best estimated price for each initiative for a 12-month development period subject to budget approval by DReps, although not all initiatives will take the full period and are reflected within their estimate. These estimates are based on the projected Full-Time Equivalents (FTEs) required from the IOE teams and suppliers over that period. However, it is common for complexities to arise during development. Should an initiative's scope or complexity necessitate resources beyond the initial estimate, we will follow a process where the IOE Lead flags the issue to the Intersect Technical Steering Committee (TSC), enabling the TSC or other appropriate administrative body to perform sufficient due diligence before any potential additional resource allocation decisions are made.

IOE plans to accept payment for its delivered services in ADA; however, the proposals herein are denominated in USD ($) for budget estimation clarity at this stage. The specific USD-to-ADA conversion rate will be determined during the contracting phase. For initiatives where IOE leads, IOE will work with Intersect to determine the mechanics of making payments to suppliers according to the specific terms negotiated by IOE in each contract structure.

Administration

IOE requests that Intersect be named as the proposal and contract administrator, fulfilling the roles outlined in the Cardano Constitution, which includes acting as the auditor for the delivered work against the proposal commitments.

Contracting

IOE anticipates establishing direct contracts with Intersect, with preferred contract structures primarily being Time & Materials, with Fixed Price contracts utilized for well-defined, limited-scope deliverables where appropriate. We will negotiate contract type (e.g., Time & Materials, Fixed Price), payment rates and terms with any suppliers.

IOE will maintain full discretion over its internal staffing decisions and, where relevant, any subcontracting arrangements necessary to fulfill the deliverables, including the discretion to bring on new or different suppliers. Furthermore, suppliers are responsible for identifying, hiring, and paying for security auditors as may be required in IOE's supplier contracts to meet delivery requirements, although specific auditors are not identified in proposals at this stage.

Collaboration and Oversight

Initiatives requiring collaboration between multiple providers will involve close coordination to maximize synergies and avoid duplication of efforts while managing interdependencies. In many cases consultation with the TSC and the Product Committee, providing guidance on solution scoping and participating in oversight activities. Contracted suppliers maintain full authority over resource allocation, work prioritization, and day-to-day project management. Software Readiness Levels (SRLs) and release cadence are dependent on funding outcomes of proposals and we expect to collaborate closely with Cardano development teams to refine.

Other Initiative Participation & Dependencies

In addition to leading the initiatives detailed in this proposal, IOE may support complementary initiatives proposed independently by other ecosystem projects. We are supportive of this approach, recognizing that multiple parties may contribute valuable solutions. It's possible some suppliers mentioned within our proposal may also submit independent proposals for related work; we view this as a positive sign of ecosystem engagement. Any potential duplication or overlap between proposals will be addressed through the community governance and reconciliation process involving DReps and Intersect to ensure efficient use of resources.

These proposals may include, among others not listed: New Anti Grinding Measure, Peras, Midgard, Gummiworm, Rust Node (Amaru), Daedalus Maintenance and Enhancement, Canonical Ledger State, Black box Ledger Conformance Testing, Conformance Testing of Consensus, Plutus Script Re-Executor, Gastronomy (UPLC debugger), Genesis Sync Accelerator, Canonical Block and Transaction Diffusion Codecs, Hoarding Node, Block Cost Investigation, Cardano-node-emulator, History Expiry, Programmable Assets, Starstream, etc.

Proposed Initiative Summaries

This section summarizes proposed initiatives, categorized by the 2025 Cardano Product Roadmap goals they support. The table that follows focuses specifically on initiatives where IOE proposes to lead and serve as the primary entity responsible for delivery.

Suppliers referenced in these summaries represent a mix of teams currently working closely with IOE, as well as expected or interested future collaborators. These designations are preliminary and will be refined as specific work packages become clearer in the coming months.

In developing these proposals, IOE aims to support the community's direction towards greater decentralization, broader access to Cardano's capabilities, and enhanced performance. This includes actively researching Aiken as a core language to support future dApp development and Rust for improving node access, scalability, and performance.

Proposed Initiatives	Product Roadmap Alignment	Funding
Automatic Formal Verification (Plutus High Assurance) Develop an automated formal verification tool for Plinth/Cardano DApps to mathematically prove correctness, detect vulnerabilities (incl. deadlocks), enhance trust, and reduce financial risk from bugs/exploits through auto-generated property checks. Although aimed at Plinth in 2025, the tool's core is adaptable to any other smart contract language (including Aiken and Plutarch), through the simple addition of a translator module. **In Collaboration With:** Anastasia Labs, MLabs, Obsidian Systems, Modus Create	Architectural Excellence	$1,859,000
Property Based Testing Tool (Plutus High Assurance) Develop a Plinth PBT Tool to automatically generate diverse inputs/actions testing specified contract properties. Helps identify edge cases, validate assumptions, improve robustness, check vulnerabilities, integrating into the Plinth workflow for rigorous, automated testing. Although aimed at Plinth in 2025, the tool's core is adaptable to any other smart contract language (including Aiken & Plutarch). **In Collaboration With:** MLabs, Obsidian Systems, Sundae Labs, Anastasia Labs	Architectural Excellence	$2,366,000

Proposed Initiatives	Product Roadmap Alignment	Funding
Static Analyzer (Plutus High Assurance) Develop a "one-click" static analysis tool for Plinth contracts to automatically detect common errors, performance issues, and anti-patterns without requiring user expertise, improving code quality, security, and developer productivity. Although aimed at Plinth in 2025, the tool's core is adaptable to any other smart contract language (including Aiken & Plutarch). **In Collaboration With:** MLabs, Obsidian Systems	Architectural Excellence	$777,140
Ouroboros Leios Implementation Begin core implementation of Leios, a next-gen L1 consensus protocol using parallel block production (Input/Endorser/Main blocks) to dramatically increase transaction throughput by orders of magnitude, addressing congestion and enabling future scale. Covers initial 12-month research-heavy design/implementation phase (18 milestones). Implements a new transaction validation structure using Endorser Blocks and voting mechanisms. **In Collaboration With:** Well-Typed, Modus Create, Sundae Labs, Serokell	Leios	$7,098,000
Cardano Node Architecture Refresh (Acropolis) Re-architect the Cardano node into a modular, event-based model (Acropolis) to improve scalability, extensibility, node diversity, and community contribution. It also seeks to improve developer experience (via better interfaces), addressing limitations of the current monolithic design. **In Collaboration With:** Greenwave, Serokell, Sundae Labs, TxPipe, SAIB, Quviq, Modus Create, MLabs, Well-Typed, PNSol	Multiple Node Implementations	$2,028,000
Hydra Development Complete Hydra v1.0 mainnet and full audit, Cardano's L2 state channel solution, provides near-instant finality and high throughput for specific use cases by enabling off-chain transactions with L1 settlement, reducing friction points like fees and latency. **In Collaboration With:** MLabs, Anastasia Labs, Sundae Labs, Obsidian Systems, Lerna Labs (for grant tooling stipends & ecosystem tooling)	L2 Expansion	$1,859,000
Minotaur AVS Launch Minotaur, an Actively Validated Service (AVS) using the Partner Chains framework, allowing new networks to leverage Cardano L1 security (stake/SPOs), positioning Cardano competitively in the AVS space and creating new SPO revenue streams. **In Collaboration With:** TxPipe, Globant, Sundae Labs	L2 Expansion	$1,900,000

Proposed Initiatives	Product Roadmap Alignment	Funding
Mithril Development Enhance Mithril protocol for secure, efficient, decentralized access to Cardano state without a full node. Speeds up node sync, enables light clients (wallets/mobile), supports L2s (Hydra/Partner Chains), and aids future scaling (Leios/Peras). Delivers decentralized signature diffusion/registration, node integration, succinct proofs, executed by stakepool operators. Addresses CIP-0137 (DMQ). **In Collaboration With:** PaloIT, TxPipe, Anastasia Labs	L2 Expansion	$1,859,000
KES Agent Implement a security enhancement for SPO KES key storage and management, improving operational security for block production and bolstering trust in the consensus layer. **In Collaboration With:** Well-Typed	SPO Incentive Improvements	$676,000
Ledger-HD Move remaining large ledger state tables (Reward accounts, InstantStake, Stake Distributions etc.) from memory to disk (using LSM tech) following UTXO-HD, to further reduce node RAM requirements, enhancing sustainability and enabling Leios. **In Collaboration With:** Well-Typed, Modus Create, Obsidian Systems	SPO Incentive Improvements	$1,352,000
Log-Structured Merge (LSM) including UTXO-HD Integrate the bespoke Well-Typed LSM-tree backend into the consensus layer (replacing LMDB) for managing on-disk state (like UTXO-HD), enabling significant scaling of ledger state size and reducing node RAM requirements/costs. **In Collaboration With:** Well-Typed, Modus Create, Obsidian Systems	SPO Incentive Improvements	$1,352,000
Revised Stake Pool Incentive Scheme Investigate and evaluate potential adjustments to the SPO incentive scheme, focusing on improving viability/fairness for smaller pools by considering existing proposals and analyzing costs/benefits. Aims to enhance decentralization and ecosystem health. **In Collaboration With:** Obsidian Systems	SPO Incentive Improvements	$1,352,000

Proposed Initiatives	Product Roadmap Alignment	Funding
Nested Transactions (Babel Fees) Implement the Nested Transactions ledger feature enabling tx batching where individual parts can be unbalanced but the whole batch must balance. Facilitates Babel Fees (paying fees with native tokens via atomic swap), lowering barriers for non-ADA users, improving DEX swaps and creating greater throughput and scaling for dApps. **In Collaboration With:** MLabs, Modus Create, Well-Typed, Sundae Labs, Anastasia Labs	Incoming Liquidity	$1,352,000
Plutus Core Roadmap Execute the roadmap for Plutus Core and its broader ecosystem, delivering key new primitives (e.g., MSM, ModExp), compiler and standard library enhancements, advanced tooling (benchmarks, dashboards), and formal verification support. These improvements will significantly enhance script efficiency, developer experience, security, and observability across the entire Cardano smart contract landscape. These upgrades will positively impact *all* smart contract languages built on Plutus Core, including Aiken, Plinth, Plutarch, Plu-ts, and others. **In Collaboration With:** MLabs	Developer / User Experience	$2,704,000
Tiered Pricing Models (Plutus High Assurance) Introduce a transaction prioritization mechanism (e.g., Standard/Priority/Assured channels) with different fees/inclusion expectations, potentially using AI congestion prediction, to improve predictability and user control during network congestion. **In Collaboration With:** Sundae Labs, Anastasia Labs	Developer / User Experience	$1,352,000
Transaction Monitoring System (Plutus High Assurance) Develop a real-time, ML-powered system to monitor Cardano transactions, detect potential fraud/anomalies, provide alerts, and offer insights into on-chain activity, enhancing ecosystem security, transparency, and visibility. **In Collaboration With:** TBD	Developer / User Experience	$1,690,000

Proposed Initiatives	Product Roadmap Alignment	Funding
Maintenance and Support Maintenance of the existing code base, ongoing support of the infrastructure (for development and operational use), ability to produce releases, reduction of technical debt – to further improve performance, reducing long-term support costs. Including enhancement and knowledge sharing across Cardano supplier ecosystem, in collaboration with Intersect's TSC. This item also includes the cost of running the Test & Tracing setup in AWS (estimated $1.5M / yr). **In Collaboration With:** Modus Create, Well-Typed, BCryptic, Galois, Globant, MLabs, Obsidian Systems, PaloIT, PNSol, Quviq, Serokell, Sundae Labs, TxPipe, Vacuumlabs, Anastasia Labs, and others.	Maintenance	$14,682,000
Audit and Security Assurance IOE plans to engage independent audits and security assurance for certain key deliverables. IOE will select qualified auditors, ensuring their independence from the delivery supplier(s), based on criteria including delivery type, code language, and security implications. Estimated costs for these audits are budgeted here as a consolidated item and are **not** allocated within the individual initiative proposals outlined previously.	N/A	$2,150,400
	GRAND TOTAL	**$48,408,540**

Proposed Initiative Detail

Automatic Formal Verification (Plutus High Assurance)

- **Description/Benefits:** Develop an automated formal verification tool for Plinth/Cardano DApps to mathematically prove correctness, detect vulnerabilities (incl. deadlocks), enhance trust, and reduce financial risk from bugs/exploits through auto-generated property checks. Although aimed at Plinth in 2025, the tool's core is adaptable to any other smart contract language (including Aiken & Plutarch), through the simple addition of a translator module.
- **Lead:** IOE (PlutusHA Team)
- **In Collaboration With:** Anastasia Labs, MLabs, Obsidian Systems, Modus Create
- **Cost:** $1,859,000
- **NOTE:** Based originally on the Coq Smart Contract Verification Framework from Anastasia Labs. Built in Lean4, uses Z3 as a backend solver. Requires only minimal annotations. Initially targets Plinth (2025), but designed to be adaptable to other smart contract languages. 2-year development scope (Year 1 & 2 deliverables specified).

Property Based Testing Tool (Plutus High Assurance)

- **Description/Benefits:** Develop a Plinth PBT Tool to automatically generate diverse inputs/actions testing specified contract properties. Helps identify edge cases, validate assumptions, improve robustness, check vulnerabilities, integrating into the Plinth workflow for rigorous, automated testing. Although aimed at Plinth in 2025, the tool's core is adaptable to any other smart contract language (including Aiken & Plutarch).
- **Lead:** IOE (PlutusHA Team)
- **In Collaboration With:** MLabs, Obsidian Systems, Sundae Labs, Anastasia Labs
- **Cost:** $2,366,000
- **NOTE:** Delivers CLI tool, VSCode integration, Documentation.

Static Analyzer (Plutus High Assurance)

- **Description/Benefits:** Develop a "one-click" static analysis tool for Plinth contracts to automatically detect common errors, performance issues, and anti-patterns without requiring user expertise, improving code quality, security, and developer productivity. Although aimed at Plinth in 2025, the tool's core is adaptable to any other smart contract language (including Aiken & Plutarch).
- **Lead:** IOE (PlutusHA Team)
- **In Collaboration With:** MLabs, Obsidian Systems
- **Cost:** $777,140
- **NOTE:** Delivers PoC, Ruleset Docs, Stable Release.

Ouroboros Leios Implementation

- **Description/Benefits:** Begin core implementation of Leios, a next-gen L1 consensus protocol using parallel block production (Input/Endorser/Main blocks) to dramatically increase transaction throughput by orders of magnitude, addressing congestion and enabling future scale. Milestones include:
    - Timing feasibility Demonstrated (Outline Delta-Q analysis report, supported by detailed quantitative timing analysis report)
    - Outline design Completed (Design Study Report, including main component-level changes, and interactions with Peras, Mithril and Genesis, as appropriate)
    - Initial Security Analysis (Report on main vulnerabilities and mitigations)
    - Detailed design completed (Design report)
    - Investigation into required code changes (Report on code changes)
    - Detailed implementation plan produced (Detailed implementation plan)
    - Cryptographic requirements identified and aligned with Peras and Mithril (Requirements document)
    - Network requirements identified and aligned with Peras and Mithril (Requirements document)
    - Common voting mechanism adapted to Leios (Software deliverable, PR integrated with Leios codebase);

  - Network diffusion layer adapted to Leios (Software deliverable, PR integrated with Leios codebase)
  - Design reviewed and updated (Updated design report)
  - Formal specification of Leios protocol and ledger changes (Agda specifications)
  - Conformance tests produced (Property tests derived from Agda specifications)
  - Initial input block implementation (software deliverable, PR integrated with Leios codebase)
  - Initial endorser block implementation (software deliverable, PR integrated with Leios codebase)
  - Initial pipeline implementation (software deliverable, PR integrated with Leios codebase)
  - Initial sharding implementation (software deliverable, PR integrated with Leios codebase)
  - Investigation into costs and incentives (report on fees/incentives changes)
- **Lead:** IOE (Networking, Consensus & Ledger Teams)
- **In Collaboration With:** Well-Typed, Modus Create, Sundae Labs, Serokell
- **Cost:** $7,098,000
- **NOTE:** Covers initial 12-month research-heavy design/implementation phase (18 milestones). Implements a new transaction validation structure using Endorser Blocks and voting mechanisms. Dependencies include LSM-integration, Ledger-HD, Network, Crypto, Voting layers, and Peras impact analysis. Development plans to employ 'Follow the Sun' methodology. Maintenance via Core Infra contract.

Cardano Node Architecture Refresh (Acropolis)

- **Description/Benefits:** Re-architect the Cardano node into a modular, event-based model (Acropolis) to improve scalability, extensibility, community contribution, and developer experience (via better interfaces), addressing limitations of the current monolithic design.
- **Lead:** IOE (Acropolis Team)
- **In Collaboration With:** Greenwave, Serokell, Sundae Labs, TxPipe, SAIB, Quviq, Modus Create, MLabs, Well-Typed, PNSol
- **Cost:** $2,028,000
- **NOTE:** Covers 1-year PoC phase focusing on lightweight ecosystem interfaces and validation modules. Dependencies include Cardano Blueprint “Eidos” (which itself depends on Acropolis and Amaru), Pallas Rust libraries, and the Caryatid microservice framework.

Hydra Development

- **Description/Benefits:** Advance Hydra, Cardano's L2 state channel solution, providing near-instant finality and high throughput for specific use cases by enabling off-chain transactions with L1 settlement, reducing friction points like fees and latency.
- **Lead:** IOE (Hydra Team)
- **In Collaboration With:** MLabs, Anastasia Labs, Sundae Labs, Obsidian Systems, Lerna Labs (for grant tooling stipends & ecosystem tooling)
- **Cost:** $1,859,000
- **NOTE:** Focus on delivering Hydra Head v1.0 + audit, lightweight node, and ecosystem support for adoption.

Minotaur AVS

- **Description/Benefits:** Launch Minotaur, an Actively Validated Service (AVS) using the Partner Chains framework, allowing new networks to leverage Cardano L1 security (stake/SPOs), positioning Cardano competitively in the AVS space and creating new SPO revenue streams.
- **Lead:** IOE (PartnerChains Team)
- **In Collaboration With:** TxPipe, Globant, Sundae Labs
- **Cost:** $1,900,000
- **NOTE:** Includes detailed cost breakdown in full proposal. Delivers live AVS network with key functions.

Mithril Development

- **Description/Benefits:** Enhance Mithril protocol for secure, efficient, decentralized access to Cardano state without a full node. Speeds up node sync, enables light clients (wallets/mobile), supports L2s (Hydra/Partner Chains), and aids future scaling (Leios/Peras). Milestones include:
    - Decentralized signature diffusion
    - Decentralized Signer registration
    - Core node integration
    - Succinct Mithril Proofs
- **Lead:** IOE (Mithril Teams)
- **In Collaboration With:** PaloIT, TxPipe, Anastasia Labs
- **Cost:** $1,859,000
- **NOTE:** Delivers decentralized signature diffusion/registration, node integration, succinct proofs, executed by stakepool operators. Addresses CIP-0137 (DMQ). Dependencies include Cardano's network layer and mini-protocols for Mithril communication.

KES Agent

- **Description/Benefits:** Implement a security enhancement for SPO KES key storage and management, improving operational security for block production and bolstering trust in the consensus layer.
- **Lead:** IOE (Consensus Team)
- **In Collaboration With:** Well-Typed
- **Cost:** $676,000

Ledger-HD

- **Description/Benefits:** Move remaining large ledger state tables (Reward accounts, InstantStake, Stake Distributions etc.) from memory to disk (using LSM tech) following UTXO-HD, to further reduce node RAM requirements, enhancing sustainability and enabling Leios.
- **Lead:** IOE (Ledger & Consensus Teams)
- **In Collaboration With:** Well-Typed, Modus Create, Obsidian Systems
- **Cost:** $1,352,000
- **NOTE:** Follow-on work from UTXO-HD.

Log-Structured Merge (LSM) including UTXO-HD

- **Description/Benefits:** Integrate the bespoke Well-Typed LSM-tree backend into the consensus layer (replacing LMDB) for managing on-disk state (like UTXO-HD), enabling significant scaling of ledger state size and reducing node RAM requirements/costs.
- **Lead:** IOE (Consensus Team)
- **In Collaboration With:** Well-Typed, Modus Create, Obsidian Systems
- **Cost:** $1,352,000
- **NOTE:** Critical enabling tech for UTXO-HD / Ledger on Disk.

Revised Stake Pool Incentive Scheme

- **Description/Benefits:** Investigate and evaluate potential adjustments to the SPO incentive scheme, focusing on improving viability/fairness for smaller pools by considering existing proposals and analyzing costs/benefits. Aims to enhance decentralization and ecosystem health.
- **Lead:** IOE
- **In Collaboration With:** Obsidian Systems
- **Cost:** $1,352,000
- **NOTE:** Discovery/Evaluation phase. Delivers a report, potentially leading to implementation/small changes.

Nested Transactions (Babel Fees)

- **Description/Benefits:** Implement the Nested Transactions ledger feature enabling tx batching where individual parts can be unbalanced but the whole batch must balance. Facilitates Babel Fees (paying fees with native tokens via atomic swap), lowering barriers for non-ADA users, improving DEX swaps and creating greater throughput and scaling for dApps.
- **Lead:** IOE (Ledger Team)
- **In Collaboration With:** MLabs, Modus Create, Well-Typed, Sundae Labs, Anastasia Labs
- **Cost:** $1,352,000
- **NOTE:** Deliverable is mainnet integration via Hard Fork; depends on prior hard forks and target hard fork feature finalization.

Plutus Core Roadmap

- **Description/Benefits:** Execute the roadmap for Plutus Core and its broader ecosystem, delivering key new primitives (e.g., MSM, ModExp), compiler and standard library enhancements, advanced tooling (benchmarks, dashboards), and formal verification support. These improvements will significantly enhance script efficiency, developer experience, security, and observability across the entire Cardano smart contract landscape. These upgrades will positively impact *all* smart contract languages built on Plutus Core, including Aiken, Plinth, Plutarch, Plu-ts, and others. In particular, the Cardano community can expect Aiken to directly benefit from these foundational improvements, reinforcing a shared ecosystem vision and delivering tangible improvements for developers across the board.
- **Lead:** IOE (Plutus Core Team)

- **In Collaboration With:** MLabs
- **Cost:** $2,704,000
- **NOTE:** Covers 1 year duration. Delivers key new primitives (e.g., MSM, ModExp), performance optimizations, compiler and standard library enhancements, and advanced tooling (benchmarks, dashboards). Includes numerous specific CIPs/features detailed in the full proposal.

Tiered Pricing Models (Plutus High Assurance)

- **Description/Benefits:** Introduce a transaction prioritization mechanism (e.g., Standard/Priority/Assured channels) with different fees/inclusion expectations, potentially using AI congestion prediction, to improve predictability and user control during network congestion.
- **Lead:** IOE (Networking & Ledger Teams)
- **In Collaboration With:** Sundae Labs, Anastasia Labs
- **Cost:** $1,352,000
- **NOTE:** Delivers framework, algorithms, AI service PoC, wallet integration PoC, testnet launch, Assured channel design, CPS/CIPs.

Transaction Monitoring System (Plutus High Assurance)

- **Description/Benefits:** Develop a real-time, ML-powered system to monitor Cardano transactions, detect potential fraud/anomalies, provide alerts, and offer insights into on-chain activity, enhancing ecosystem security, transparency, and visibility.
- **Lead:** IOE (PlutusHA Team)
- **In Collaboration With:** TBD
- **Cost:** $1,690,000
- **NOTE:** Delivers SOTA research/spec and Alpha backend/frontend.

Maintenance and Support

- **Description/Benefits:** Maintenance of the existing code base that includes but is not limited to code modernization and addressing technical debt, bug fixes and disaster recovery, full node wallet maintenance and enhancements, and node performance improvements. It also involves preserving and sharing the vital knowledge embedded within the team. Items include but are not limited to:
    - Node Bug Fixing
    - Release Management Process
    - E2E Testing, Conformance testing
    - Design and Code Security Review
    - Performance analysis and system integration level benchmarks
    - Node Performance Improvements
    - SPO Support
    - Network monitoring and performance management
    - Disaster Recovery
    - Maintain Testnets
    - L1, L2, L3 Support

  - And many of the other functions required to keep Cardano secure, performant and resilient.
- **Lead:** IOE
- **In Collaboration With:** Modus Create, Well-Typed, BCryptic, Galois, Globant, MLabs, Obsidian Systems, PaloIT, PNSol, Quviq, Serokell, Sundae Labs, TxPipe, Anastasia Labs and Vacuumlabs. Other suppliers to be engaged as required.
- **Cost:** $14,682,000
- **NOTE:** Scope includes the existing code base and future maintenance of initiatives delivered under this proposal following their development, verification, validation, and mainnet deployment. While initially managed by IOE, the intent is for maintenance to transition to a range of suppliers supported by knowledge sharing. This item also includes the cost of running the Test & Tracing setup in AWS (estimated $1.5M / yr).

Audit & Security Assurance

- **Description/Benefits:** IOE plans to engage independent audits and security assurance for certain key deliverables. IOE will select qualified auditors, ensuring their independence from the delivery supplier(s), based on criteria including delivery type, code language, and security implications. Estimated costs for these audits are budgeted here as a consolidated item and are **not** allocated within the individual initiative proposals outlined previously.
- **Cost:** $2,150,400
- **NOTE:** The audit cost represents an estimated percentage based on the delivery costs of key deliverables across all proposed initiatives.

Version History

Version	Date / Action	Description
1.0	April 7, 2025	Initial publication on GovTool
1.1	April 10, 2025	Adjusted GovTool proposal to render markdown formatting; realigned project collaborator per request.